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ALNOR

ELECTRONIC BALOMETER® CAPTURE HOOD WITH APM150 MULTI-PURPOSE METER

OWNER'S MANUAL

SAFETY NOTICE

When using the Electronic Balometer to check air flow at ceiling diffusers, make certain that you can safely raise and hold the unit while making measurements, especially when working on a ladder.

Observe all necessary precautions so that the unit does not get caught in moving machinery.

The Electronic Balometer is not designed for gas mixtures other than air. Any use with corrosive or other dangerous or explosive gas mixtures is not recommended.

WARNING

The meter on the Electronic Balometer is designed to measure only low voltages in the range of 0 to 3 volts. Use only ALNOR probes designed for this meter.

CAUTION

Due to its size and shape, care should be taken when carrying the assembled instrument from place to place so that it does not accidentally bump into people or objects.

Special nylon material is used to manufacture the Electronic Balometer hoods because of its permeability and toughness. Precautions should be used however, so that it is not ripped by accidental contact with sharp objects.

BATTERY CAUTION

If the instrument is not to be used for more than two months, remove the batteries and store them in a separate plastic container to avoid possible damage from leakage.

WARRANTY

Warranty information is specified on the last page of the manual. The reply card is enclosed elsewhere in this package. Failure to return the reply card may void the warranty.

WARNING

Opening or otherwise attempting to service your Alnor instrument will void the warranty or factory calibration. Please read the warranty statement and calibration instructions carefully.

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1 GENERAL DESCRIPTION

The Alnor APM150 Electronic Balometer system is designed to measure supply or exhaust air flow from diffusers and grills in heating ventilating and air conditioning systems. As shown in Figures 1 and 2, the assembly consists of a base with a nylon hood, APM150 meter, handles and manifold and base. The meter shown in Figure 3 provides a digital read out in cubic feet per minute (CFM), cubic meters per hour (m^3/h), or liters per second (l/s). The range of measurement is from 50 to 2000 CFM (85 to 3400 m^3/h, 24 to 945 l/s). The meter conveniently sums and averages flow for up to 9999 points.

An adjustable tilt mechanism allows the user to comfortably read the meter from a wide range of angles. The instrument is auto-scaling and works without the use of screens or additional attachments. A HOLD feature is provided to freeze readings, allowing the user to concentrate on correctly placing the Balometer at the diffuser or grill. Five user selectable time constants are available for a wide response time capability. The meter is programmed to recognize other ALNOR probes which can be connected using a special adapter. These probes will allow the measurement of relative humidity, temperature or air speed without the purchase of an additional meter.

The APM 150 Electronic Balometer system has a manifold and base (see Figure 2) that is designed to provide improved flow averaging on either supply or exhaust modes. The unique grid design correctly averages the flow at the 16 carefully selected radial positions. The flow is then measured using a thermal sensor which provides fast, accurate readings throughout the measurement range. For most diffusers, the use of K factors or multi-point traverses is eliminated. Tables 1 and 2 describe the key features of the APM 150 Electronic Balometer system.

For increased flexibility the unit can be supplied with up to five sizes of nylon hoods which fit interchangeably on the instrument base. The 2 X 2 (610 X 610 mm) foot size is standard and is attached to its own frame. Other hoods (1 X 4, 2 X 4, 1 X 5 and 3 X 3 foot) (305 X 1220, 610 X 1220, 305 X 1525 and 915 X 915 mm) are used with frame pieces which are assembled by the user. The APM 150 Electronic Balometer system is available with a light weight soft carrying case that is designed to accommodate all five hood sizes.

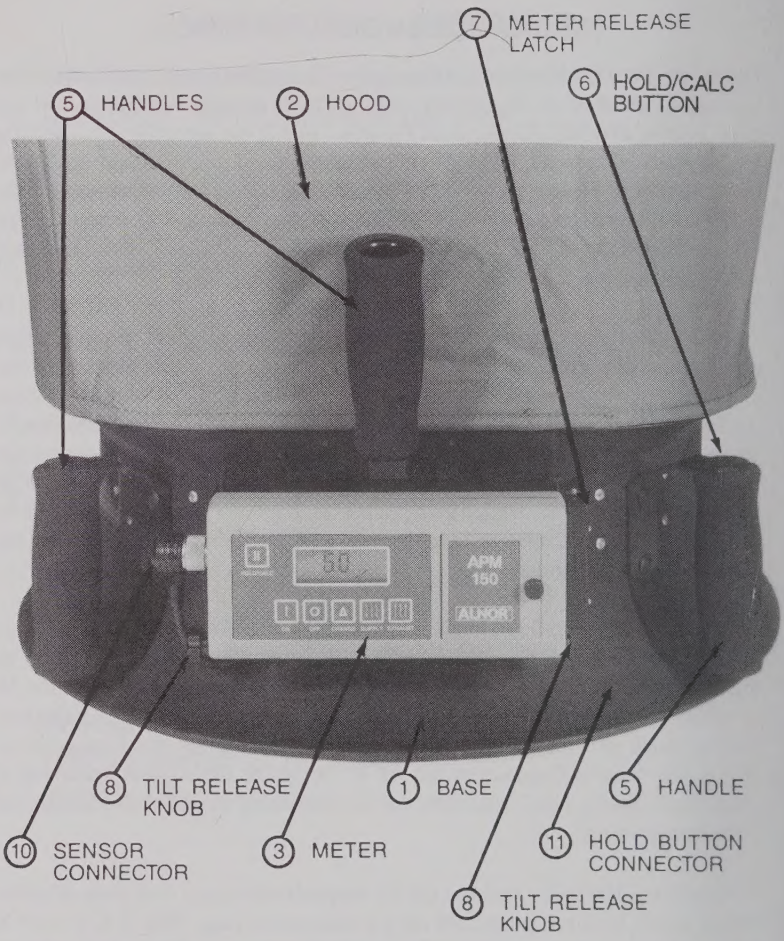


Figure 1. Front View Instrument Assembly

Table 1 Description of Key Balometer Features (Reference Figures 1 and 2)

INDEX NO.	NAME	DESCRIPTION
1	Base	The high impact polyethylene base is over 7 inches (178 mm) tall and has a 20 inch (51 cm) diameter flared inlet.
2	Hood	Hood material is nylon. Five hood sizes are available. The 2 ft X 2 ft (610 X 610 mm) hood is standard.
3	Meter	APM 150 meter provides a digital read out of air volume flow or temperature. The meter is removable. See Table 2 for detailed information.
4	Manifold	Two sets of 16 tubes are joined at a central hub. The manifold collects air in either Supply or Exhaust modes.
5	Handles	Two permanent and one removable handle are provided to make the unit easy to use and carry.
6	Hold/Calc Button	Press this button to freeze the display, or to view the sum and average.
7	Meter Release Latch	The meter can be removed from the base and used independently with other Alnor probes. This spring loaded latch is used to secure the meter to the base. To remove the meter, remove the connector, depress the latch and swing the meter out.
8	Tilt Release Knob	A pair of tilt release knobs are located under the meter. When loose, the meter assembly can be tilted for better viewing. When the desired angle is set, the knobs are tightened.

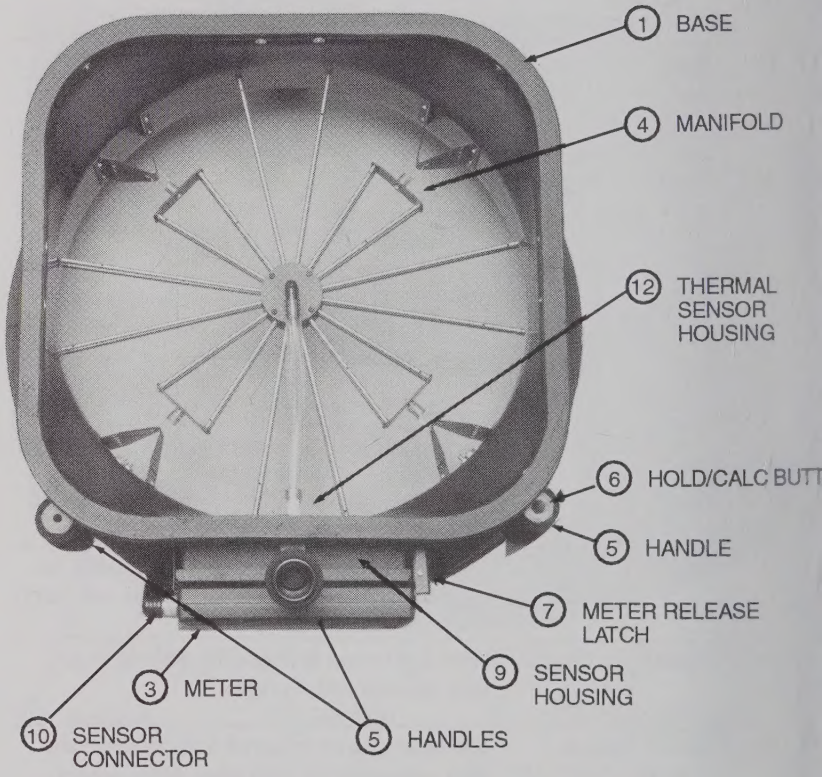


Figure 2. Top View Instrument Assembly

Table 1 Description of Key Balometer Features (Continued)
(Reference Figures 1 and 2)

INDEX NO.	NAME	DESCRIPTION
9	Sensor Housing	The electronics associated with the sensor are located in this housing. The electronics are connected to the meter through the sensor connector.
10	Sensor Connector	A 12-pin round locking connector is used to mate the sensor electronics to the meter.
11	HOLD/CALC Button Connector	The Hold/Calc button located in the right hand handle is connected to the sensor electronics through the hold button connector.
12	Thermal Sensor Housing	An aluminum housing protects a pair of thermal sensors. One sensor measures ambient air temperature. A second sensor is heated and measures air flow from the manifold.

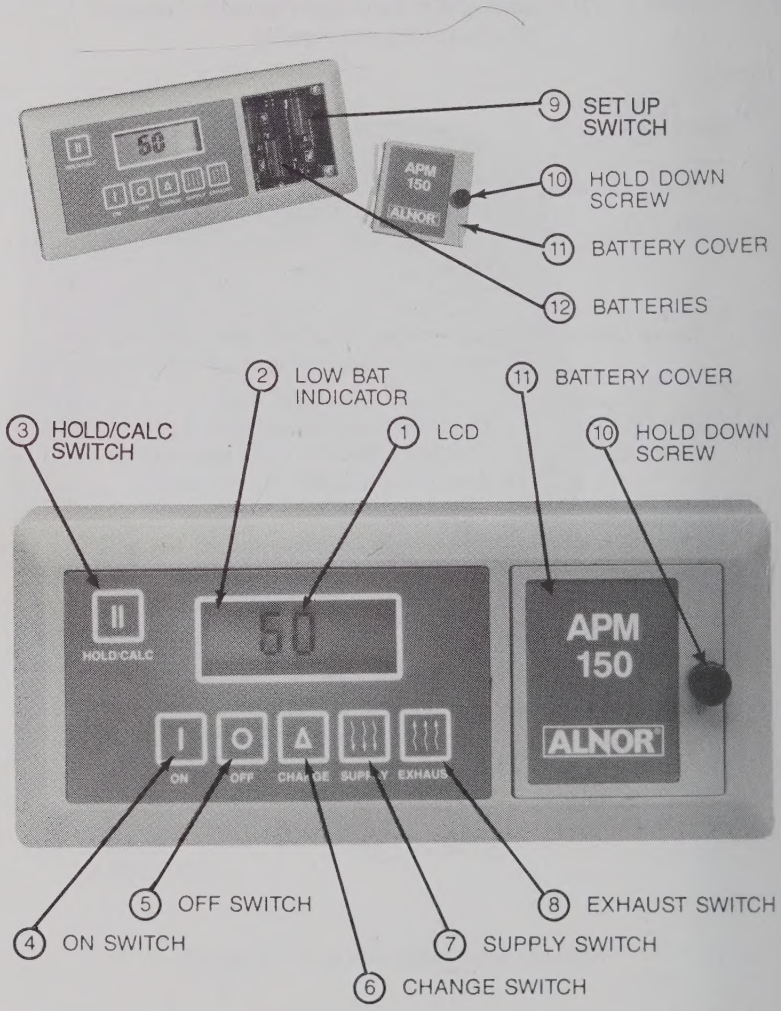


Figure 3. Front View Meter Assembly

Table 2. Description of Meter Panel
(Reference Figure 3)

INDEX NO.	NAME	DESCRIPTION
1	LCD	A four and one-half digit Liquid Crystal Display (LCD) shows the volume flow rate or temperature. When initially turned on, the display will also show the mode (Supply "SP" or Exhaust "Eh"), type of measurement (Volume flow, temperature), method (Standard "Stnd" or Actual "ACtU") and time constant setting (1 through 5).
2	Low Bat Indicator	Low battery indicator flashes LO BAT when the battery needs replacing. When the LO BAT first appears, a minimum of one hour battery life remains. If the display is blank and the LOW BAT is flashing, the batteries are too low for accurate readings and must be replaced.
3	HOLD/CALC Switch	Press this switch to freeze the display, or to view the sum and average.
4	ON Switch	The ON switch turns the instrument on when momentarily depressed. The meter will turn on using the measurement units of the attached sensor which were in use when sensor was last used. The meter always starts up in Supply mode.
5	OFF Switch	OFF switch turns the instrument off when momentarily depressed.
6	CHANGE Switch	Holding down the CHANGE switch causes the display to cycle through all units appropriate for the sensor that is attached to the meter. Release the CHANGE switch when the desired unit is shown on the display. Push CHANGE for about 1 second to check current units.

Table 2. Description of Meter Panel (Continued)
(Reference Figure 3)

INDEX NO.	NAME	DESCRIPTION
7	SUPPLY Switch	When pressed and released, selects the supply measurement mode. Display will indicate "SP" and then the measured values.
8	EXHAUST Switch	When pressed and released, selects the exhaust measurement mode. Display will indicate "Eh" and then the measured values with a negative "–" sign.
9	Set-Up Push Button	It is used to set up the meter for measurement units, time constant setting and calibration and is located inside the meter next to the batteries. To access it, loosen the hold down screw and then lift the screw up. While holding the screw up, push to the left and then lift out the battery cover.
10	Hold down Screw	A multi-turn screw is used to keep the battery cover and batteries in place during use. When re-tightening, do not over tighten. The Hold down screw may be used to reach the set-up push button.
11	Battery Cover	The battery cover is held in place by the spring action of "wings" located on the left hand side of the cover and by the hold down screw. User can access the battery compartment by loosening the hold down screw, pulling the screw up and pushing the cover to the left while lifting out.
12	Batteries	Three type AA alkaline batteries provide power to the meter and probes.

2 PREPARATION FOR USE

Before removing any parts from the carrying case, the arrangement of the various items should be noted so that re-packing can be done easily. See Figures 4 and 5.

If your instrument is equipped with more than one hood, the frame channels needed to support other sizes are stored under the base of the Balometer inside the accessory case. The extra hoods are stored around the Balometer base.

Step 1: Remove the tie down straps at the two locations shown in Figure 4.

Step 2: Holding on to the 2 ft X 2 ft (610 X 610 mm) hood frame, gently lift up the entire instrument assembly and set it to the side of the carrying case.

Step 3: The accessory case, located underneath the Balometer, is now exposed. Lift up on the pull tab and pull back to expose the accessory items. See Figure 5. Remove the hood support, support dowels and handle from the case. Figure 5 also shows the packing position of the accessory frame channel pieces. If installing a different hood size, remove these pieces at this time.

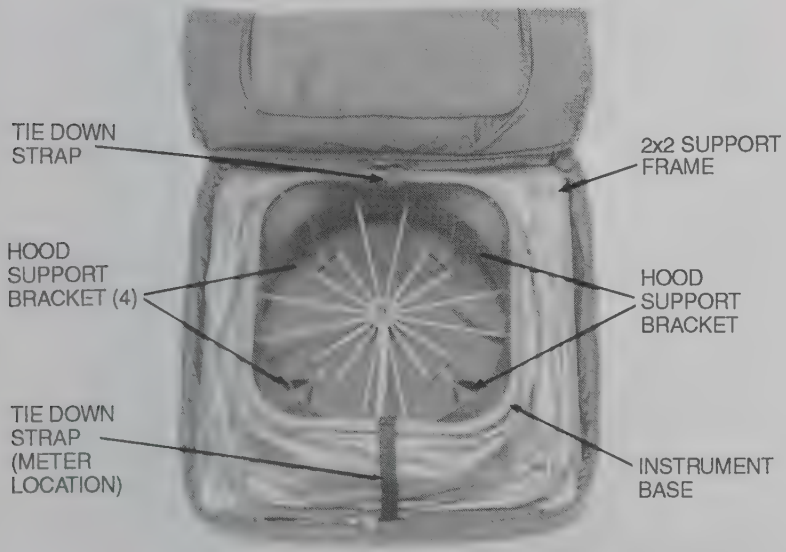


Figure 4. Top View Carry Case

NOTE

The APM 150 Electronic Balometer system comes from the factory with a 2 ft X 2 ft (610 X 610 mm) nylon hood installed on the base. The following steps will complete the preparation of the Balometer for use with this hood. If a different hood size is required for first time use, go to the section titled ALTERNATE HOOD INSTALLATION.

Step 4: Unfold the spider assembly mechanism. This mechanism will now be inserted into the four hood support brackets located in each corner of the base. Grasp two of the wire formed legs in each hand. Insert each of the legs into the center hole of the hood support brackets. Grasp the remaining two legs and insert them into the remaining two holes of the hood support brackets. If it is later found that the hood is not held as tautly as required, the spider assembly can be moved upward to compensate.

Step 5: Place the four support dowels on the hood support mechanism as shown in Figure 6. The aluminum tips on the dowels should be facing up. If a 2 X 4 or 3 X 3 (610 X 1220 or 915 X 915 mm) hood set is to be used, the set of 8 inch (200 mm) long dowels must be added to either end of the long dowels.

Step 6: Raise the hood up until it is taut. Insert a support dowel into one of the corners of the frame nearest to you. Take care to ensure that the support dowel is not pressing against the hood material. Insert a second support dowel into the remaining corner close to you. Lift up

Figure 5. Unpacking Accessory Case

the far side of the hood. Pressing firmly down on the support dowel, move the dowel into the third corner. Finally, pressing down on the last dowel, insert it into the remaining corner.

Step 7: If desired, install the detachable handle next. Screw it hand tight into its mating thread located over the meter as shown in Figure 6.

CAUTION

Make a habit of checking the tightness of this handle each time before use. Be sure it does not loosen while the instrument is being used to take readings, or while it is being carried from place to place.

Step 8: Verify that the sensor connector is attached to the meter. If it is not attached, line up the key as shown in Figure 7 and firmly press the connector into the meter. Tighten the connector by rotating the knurled ring.

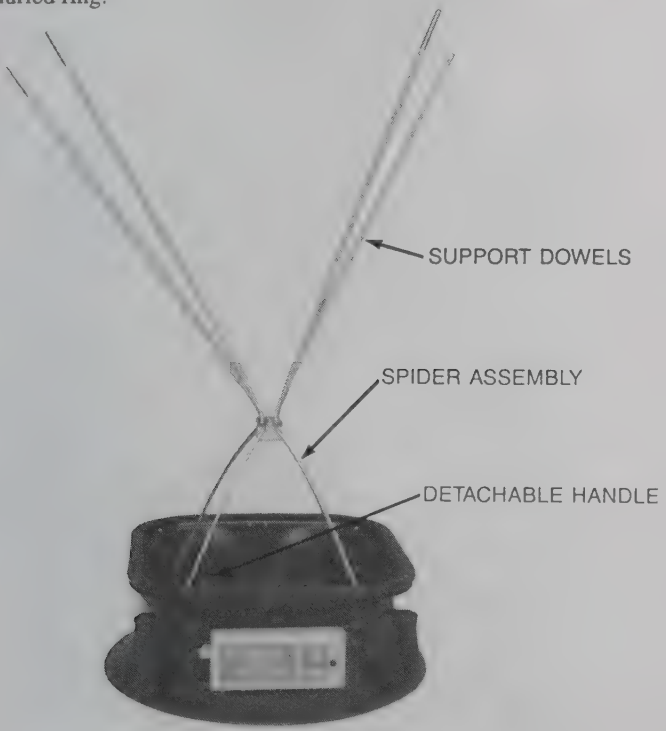


Figure 6. Instrument Assembly

Step 9: Verify that the handle hold button connector is plugged into the sensor module as shown in Figure 8.

Step 10: The meter may be tilted for convenient viewing by loosening the tilt release knobs located under the meter. Adjust the meter to the desired angle and tighten the knobs. See Figure 9 for various ways to hold the Balometer.

Figure 7. Sensor Connector Attachment

Figure 8. Hold Button Connector Attachment

To begin using the APM 150 Electronic Balometer system, proceed to the section STEP BY STEP OPERATION.

TIP: Before using the Electronic Balometer, allow the unit to warm up for 15 minutes to achieve best possible accuracy. The unit may be turned on before the hood is set up to minimize waiting time before taking measurements.

Figure 9 Holding Balometer for Measurement

ALTERNATE HOOD INSTALLATION

Refer to Figures 10 through 13 to determine the frame channels needed to assemble any of the standard sized frames. Select the pieces required for the frame size desired and assemble with the aid of the appropriate figure. Each channel is labeled with its number for easy identification. Several sections (numbers 1, 3 and 4) consist of a straight channel portion (each a different length) and a corner piece. This corner piece has an eyelet and slot arrangement which mates with a similar eyelet and slot at the end of the straight portion of the channel pieces (see Figure 14). These pieces can be slid together and are self locking by means of a retention spring. The arrangement forms a rugged frame which is additionally strengthened when the hood is attached.

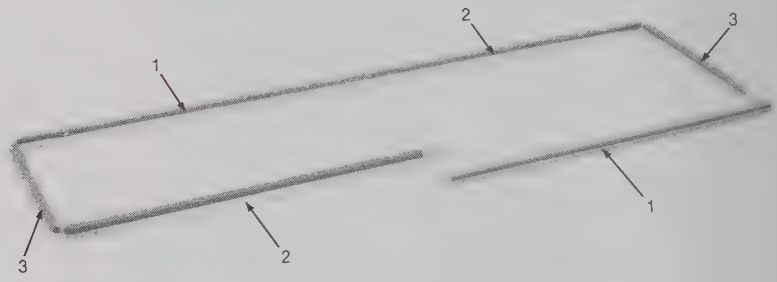


Figure 10. 1 X 4 Frame (305 X 1220 mm)

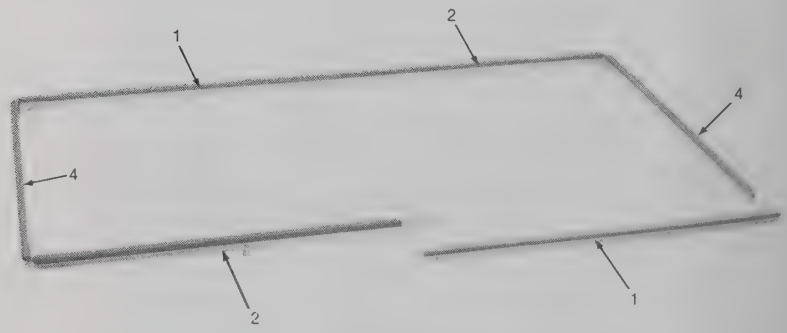


Figure 11. 2 X 4 Frame (610 X 1220 mm)

The number 1 and 5 channels also have a wing nut at the straight end which will mate with an angle and studs on the ends of numbers 2, 5 and 6 to form the longer frame sides (see Figure 15).

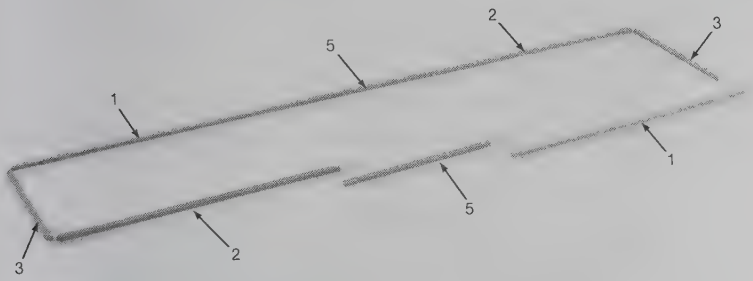


Figure 12. 1 X 5 Frame (305 X 1525 mm)

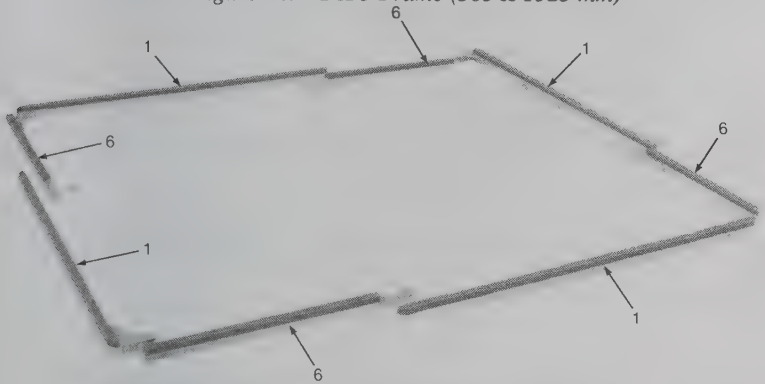


Figure 13. 3 X 3 Frame (915 X 915 mm)

Figure 14. Frame Corner Assembly

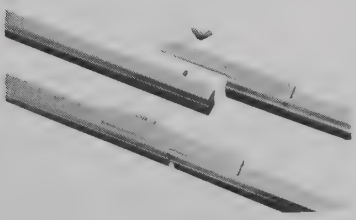


Figure 15. Frame Side Assembly

Each hood is constructed in a trapezoidal shape, sewn together so that one open end forms a square attachment to the base, and the other forms a square or rectangle large enough to fit its matching frame assembly. Around each end of the hood an elastic "shock" cord has been sewn into the hood. This cord is of a size such that it can be pushed into the open side of the U-shaped channels of the frame and around the top of the base.

In general, attach a hood to the frame first, and then to the base unit. By stretching around the corners the cord is slightly reduced in diameter and is easier to press into the channel.

NOTE

The hood corners should always be aligned with the corners of the base, near the hood support brackets. The base has rivets located in the corners which can be used as a guide for aligning the hood corners.

3 STEP BY STEP OPERATION

Step 1: Verify that the sensor connector is attached to the meter as described in the Preparation for Use section. Also verify that the handle hold button connector is attached to the sensor housing.

Step 2: If the meter is off, turn the meter on by pressing and then releasing the ON switch. When connected to the base, the meter will display in sequence the following;

A. – – –
B. Mode: Supply "SP"
C. All LCD segments
D. Measurement Units
E. Measurement Method: Standard "Stnd" or Actual "ActU"
F. Time constant setting (1 through 5)
G. Measured Values

In general if a sensor or probe is below its allowable range, the meter will display 0. If a probe is beyond its allowable range, the meter will display "Or" for over-range. **The meter always starts up in Supply mode "SP".**

Step 3: If a different measurement unit is desired, press and hold the CHANGE button until the desired units are shown on the display. When CHANGE is released, the instrument will briefly display the chosen units, then the measurement values in the chosen unit.

CAUTION

Do not turn the meter off while the unit of measurement (for example CFM or LPS) is on the display. During this period, the meter is writing information to the memory. If the meter is turned off during this period, the sensor's memory may be incorrect. After changing units, wait until readings are displayed (about one second) before turning instrument off.

NEVER DISCONNECT THE SENSOR CONNECTOR WHEN THE METER IS ON.

Step 4: If measurements from a supply grill are going to be made, press and release the supply switch (downward arrows). The meter will show "SP" and then the measured values. If measurements from an exhaust grill are to be made, press and release the exhaust switch (upward arrows). The display will show "Eh" and then measured values with a "–" sign.

Step 5: Bring the Balometer into contact with the perimeter of the diffuser or grill to be measured. See Figure 9 for guidance in how to hold the Balometer when taking measurements. To assure maximum accuracy, the foam gasket along the top of the frame must be firmly in contact with the surface all around the opening. Take care to ensure that your body or other objects do not accidentally affect the readings by blocking or diverting the air flow at either the entry or exit of the Balometer. This is especially a concern for flows under 100 CFM (50 l/s).

WARNING

WHEN USING THE BALOMETER TO CHECK AIR FLOW AT CEILING DIFFUSERS MAKE CERTAIN THAT YOU CAN SAFELY RAISE AND HOLD THE UNIT WHILE MAKING THE MEASUREMENT. THIS IS ESPECIALLY IMPORTANT WHEN WORKING ON A LADDER. MAKE SURE THAT THE UNIT CAN NOT BE CAUGHT IN MOVING MACHINERY.

Step 6: If readings are fluctuating or if you want to freeze the display, press either theHOLD/CALC switch in the meter or the HOLD/CALC button in the right handle. Release it when the display shows "hOLd". The display will flash to indicate that the meter is in "hold" mode. To terminate the "hold" mode and take additional readings, briefly press and release the HOLD/CALC switch or button. The display will show "- - -" to indicate that the "hold" mode has ended and that the value was entered as a new point into the sum and average calculations.

Another method to reduce the fluctuation in readings is by increasing the value of the time constant in the meter. Instructions for changing the time constant are in the METER SET UP OPERATION section.

Step 7: To display the average and sum, press and hold the HOLD/CALC switch. The display will show "hOLd" for approximately 2 seconds. Then it will show "SUM". Release the switch. The meter then displays the TOTAL SUM of FLOW VOLUME in memory. Then it will display "Pnt" followed by the NUMBER OF READINGS in memory. Finally, the meter shows "AVE" followed by the AVERAGE of the readings in memory. The meter then displays "- - -" and returns to take new readings. These new readings continue to be added to the sum (from which the average is calculated) until the meter is turned off. Only this resets the sum and average calculations.

Note that the TOTAL SUM of FLOW VOLUME is available only when the meter is measuring volumetric flow rate (such as CFM). Otherwise, such as when measuring temperature, the meter will display only the NUMBER OF READINGS and the AVERAGE. If the memory is empty, the meter will not display SUM or AVERAGE, and will show only "Pnt" followed by "0" to indicate that memory is empty.

Figure 16. Removing the Meter from the Base

Step 8: The Electronic Balometer is set to read in standard volume flow when it leaves the factory. To read in actual flow follow the instructions in the METER SET UP section which follows.

NOTE

A short description of the Electronic Balometer's key features is printed on the back of the meter. To see the menu, remove the meter by squeezing the meter release latch and lift out the meter as shown in Figure 16. Replace the meter by squeezing the release latch, inserting the left side of the meter under the "L" bracket then laying the meter flat against the sensor housing before releasing the latch. Make sure that the meter is secure before moving the Balometer.

METER SET UP OPERATION

General

The APM 150 Electronic Balometer meter can be customized by deactivating measurement units that are never used. Units that are deactivated can be reactivated at a later time if desired. The time response of the system may also be changed. Five time constant settings are available that will allow the instrument to respond to the slightest air movements, or smooth the readings to various degrees. This section of the manual explains how to make these adjustments.

The meter has a special set up menu that allows the following items to be viewed and or changed;

A. Units of measurement configuration	Unit
B. Time constant setting	tc
C. Density setting (Actual or Standard flow)	denS
D. Calibration	CAL

A short description of what can be done under each of the menu items is provided in TABLE 3. This menu can only be accessed by pressing the Set Up switch located behind the battery compartment door on the printed circuit board. See Figure 3 for the location of this button.

The units, time constant and density settings may be changed by any user. The calibration settings should only be changed by those knowledgeable about calibration procedures and who have proper calibration equipment. Detailed steps on calibration are provided in the manual section titled CALIBRATION.

Table 3. Special Menu Items

CATEGORY	MENU ID	DESCRIPTION
Units	Unit	Measuring units associated with a given sensor or probe can be enabled or disabled. For example, if liters per second (l/s) is never used, it can be deactivated from the meter. At a later time it can be reactivated. Units that are available on the Electronic Balometer are:
	CFn	Cubic feet per minute
	LPS	Liters per second
	cnh	Cubic meters per hour
	C	Centigrade degrees
	F	Fahrenheit degrees
Time Constant	tC	The time constant or response time of the meter can be adjusted between a value of 1 (fast) and 5 (slow). This adjustment only applies to the flow mode. The temperature mode always responds at the fastest possible speed.
Density	dEnS	Either standard or actual volume flow can be read with the meter. Standard (Stnd) flow is referenced to .075 pounds per cubic foot (1.2 kg/m^3). Actual (ACtU) flow is referenced to the atmospheric pressure at the time of calibration. See sections 9 and 11 of this manual for further information on density.
Calibration	CAL	Various calibration options are available. After the CAL option is chosen, the following menu items are accessible:
	SC 2	Show calibration constants for channel 2 (supply flow).
	SCr2	Show calibration constants for channel 2 (reverse or exhaust flow)
	SC 1	Show calibration constants for channel 1 (temperature).

Table 3. Special Menu Items (Continued)

CATEGORY	MENU ID	DESCRIPTION
Calibration (Continued)	CC 2	Change calibration constants for channel 2 (supply flow).
	CCr2	Change calibration constants for channel 2 (reverse or exhaust flow)
	CC 1	Change calibration constants for channel 1 (temperature).
	360	Calibrate meter for voltage input on channel 1.
	UOLT	Display voltage reading from channel 1.
	ArEA	After the area option is chosen, the following menu items are accessible:
	SC A	Show area factor of base.
	CC A	Change constant for base area factor.

A. UNITS of MEASUREMENT CONFIGURATION

1. Verify that the sensor is connected to the meter and that the meter is off.

2. Remove the battery compartment door by loosening the battery cover hold down screw, lifting the screw up and then pushing the cover to the left. Lift up on the screw to pull the cover out.

3. While pressing the Set Up switch (SW1), turn the meter on. Release the Set Up switch.

4. The meter will display "Unit". Depress the CHANGE switch briefly and release. The display will automatically cycle through the units associated with the probe or sensor that is attached.

5. If a unit is not required during the normal run operation, it can be removed by briefly depressing and releasing the CHANGE switch when the unit is displayed. A negative sign (–) will then appear in front of the unit.

6. If the unit designation has a negative sign (–) in front of it, this unit will not be displayed during the normal run mode. If the unit is desired, briefly depress and release the CHANGE switch. The negative sign (–) will be removed.

7. After the desired units have been added or deleted, press and hold the CHANGE switch until the meter displays "Unit". The meter will then go into the normal start up cycle.

CAUTION

Do not turn off the meter while the probe type, measurement mode (for example l/s) or time constant setting is on the display. During this period, the meter is writing information to memory. If the meter is turned off during this period, the probe's memory may be incorrect. After changing units, wait until readings are displayed (about 1 second) before turning the meter off.

8. Replace the battery compartment cover by inserting the "wings" on the left into the case and pushing to the left while pressing in.

9. Take readings as required.

10. Turn the meter off by pressing the OFF switch.

B. TIME CONSTANT SETTING CHANGE

This procedure will affect channel 2 (flow) of the attached sensor or probe only. Channel 1 (temperature) is always set at the fastest possible speed.

1. Verify that the sensor is connected to the meter and that the meter is off.

2. Remove the battery compartment door by loosening the battery cover hold down screw, lifting the screw up and then pushing the cover to the left. Lift up on the screw to pull the cover out.

3. While pressing the Set Up switch (SW1), turn the meter on. Release the Set Up switch.

4. The meter will display "Unit". Press the Set Up switch again. The meter will display "tC".

5. Briefly press and release the CHANGE switch. The display will show the value "1".

6. Press and release the Set Up switch to index through the time constant settings "1" through "5". The value "1" represents the fastest response possible. The value "5" represents the slowest response. The % override indicates the value that the input must reach to allow the meter to be instantly updated.

   For example, assume the meter is set to tC setting 3 and is reading 1000. If the flow abruptly changes to 1200, the meter will instantly update to 1200 and bypass the averaging scheme. This is because the new value is more than 15% of the old reading. If the flow abruptly changes to 1140, the meter will take 6 seconds to reach 95% 0f 1140.

tC	AVERAGING SCHEME % New	% Old	OVERRIDE % of Reading	Time (sec)*
1	100	0	0	3.5
2	50	50	15	9
3	25	75	15	23
4	17	83	25	35
5	10	90	15	60

* Time to reach 95% of input

7. When the desired time constant value is displayed, press and release the CHANGE switch. The meter will then go into the normal start up cycle.

8. Replace the battery compartment cover by inserting the "wings" on the left into the case and pushing to the left while pressing in.

9. Take readings as required.

10. Turn the meter off by pressing the OFF switch.

C. DENSITY SETTING

1. Verify that the sensor is connected to the meter and that the meter is off.

2. Remove the battery compartment door by loosening the battery cover hold down screw, lifting the screw up and then pushing the cover to the left. Lift up on the screw to pull the cover out.

3. While pressing the Set Up switch (SW1), turn the meter on. Release the Set Up switch.

4. The meter will display "Unit". Press the Set Up switch again. The meter will display "tC". Press the Set Up switch one more time. The display will show "dEnS"

5. Briefly press and release the CHANGE switch. The display will show "ACtU" for actual flow.

6. Press and release the Set Up switch to cycle between actual "ACtU" and standard "Stnd" modes.

7. When the desired mode is displayed, press and release the CHANGE switch. The meter will display "dEnS". Press and hold the CHANGE switch for about 3 seconds. The meter will then go into the normal start up cycle.

8. Replace the battery compartment cover by inserting the "wings" on the left into the case and pushing to the left while pressing in.

9. Take readings as required.

10. Turn the meter off by pressing the OFF switch.

D. AREA SETTING

The throat area of the base is set at the factory and should not be changed by the user. The nominal setting is 1.268 square feet.

4 REPACKING

Figures 4 and 5 will be helpful when re-packing the instrument.

With the exception of the 2 X 2 (610 X 610 mm) hood and frame, hoods must be removed from their support frames, re-rolled and packed in the accessory case. All frames (except the 2 X 2 (610 X 610 mm) size) must be disassembled for storage in the carrying case. Corner sections can be pulled apart when the retaining spring is pushed out of the hole into which it snaps at assembly. Put wing nuts back on their threads before storing to avoid losing them.

All the frame pieces will fit in the accessory case. Place the long pieces under the elastic straps to secure them. Note that there are two set of straps. The top set is visible when the accessory flap is pulled back. The bottom set is located deep inside the pocket of the accessory case. Place the small pieces on the side that has the small flap. The pieces are held by an elastic strap at the bottom. The flap is put over the top of the short frame pieces to prevent them from sliding out during transportation.

Dismount the dowels and pack them into the accessory case under the elastic straps.

The spider assembly is removed by slightly compressing the ends of the long wires and sliding them out of their mounting holes. Store it in the accessory case.

Remove the detachable handle if it has been mounted, and store it in the accessory case under an elastic strap.

Close the main flap of the accessory case. Place the base assembly in the center of the case, on top of the accessory compartment. The meter side is placed at the front of the case. The 2 X 2 (610 X 610 mm) frame is placed in the carrying case next.

Locate the two tie down straps. It is important to use these straps to secure the base during transportation. The tie down strap located at the front of the case is looped around the inside of the base and the outside of the frame assembly. It is placed just to the right of the flexible tubes that connect the manifold to the sensor. Make sure this strap is secure. Locate the rear tie down strap and secure it. If other optional hoods are part of the kit, they are rolled and placed on the sides of the base.

The carrying case may now be closed. Take care to make sure that when zipping the case, all hood material is neatly tucked inside. The case has a convenient flap sewn into the handle to make carrying the case easier. Loop the flap under the handle.

5 LIST OF MODELS AND PARTS

MODEL NO.	PART NUMBER	DESCRIPTION
APM150	632-200-100	Meter and pouch only
APM151	634-593-400	Kit with Base, Meter, 2 X 2 (610 X 610 mm) hood, Carrying case
APM153	634-593-401	Kit with Base, Meter, 2 X 2, 2 X 4, 1 X 4 ft hood (610 X 610, 610 X 1220, 305 X 1220 mm), Carrying Case
APM155	634-593-402	Kit with Base, Meter, 2 X 2, 2 X 4, 1 X 4, 1 X 5, 3 X 3 ft hood (610 X 610, 610 X 1220, 305 X 1220, 305 X 1525, 915 X 915 mm), Carrying Case
265	634-431-000	Probe for measuring air velocity and temperature
265E	634-431-001	Probe for measuring air velocity and temperature (for use with capture horns)
220	634-200-001	Probe for measuring relative humidity and temperature
—	632-200-001	Adapter cable for connecting 265 and 220 probes to APM 150 meter
—	632-200-002	Calibration cable for APM 150 meter

PARTS LIST

151 Electronic Balometer Kit with 2 X 2 Hood

PART NO.	QTY.	DESCRIPTION
534-593-173	1	Handle Assembly (Center)
534-513-315	1	Carrying Case
534-513-313	1	Manifold Assembly
534-513-308	1	Spider Assembly
534-513-034	1	2 X 2 (610 X 610 mm) Cloth Hood
534-513-031	1	2 X 2 (610 X 610 mm) Frame
534-513-016	4	Support Dowels
116-159-068	1	Owner's Manual

153 Electronic Balometer Kit with 3 Hood Sizes
Same as Model 151, with the following

PART NO.	QTY.	DESCRIPTION
534-513-018	2	#1 Channel
534-513-017	2	#2 Channel
534-513-020	2	#3 Channel
534-513-021	2	#4 Channel
534-513-032	1	2 X 4 (610 X 1220 mm) Cloth Hood
534-513-033	2	1 X 4 (305 X 1220 mm) Cloth Hood
534-513-042	4	Dowel Extension

155 Electronic Balometer Kit with 5 Hood Sizes
Same as Model 153, with the following

PART NO.	QTY.	DESCRIPTION
534-513-018	2	#1 Channel
534-513-040	2	#5 Channel
534-513-041	4	#6 Channel
534-513-035	1	1 X 5 (305 X 1525 mm) Cloth Hood
534-513-036	1	3 X 3 (915 X 915 mm) Cloth Hood

6 PERFORMANCE CHECK

GENERAL

In general, the performance of air flow instruments in the field can be very hard to assess. Measuring air flow is much more difficult than measuring other parameters such as voltage, resistance, temperature or pressure. The industry practice is to specify accuracy in terms of the manufacturer's ability to consistently calibrate instruments to laboratory standards. It is unlikely that the stated factory air flow accuracy specification can always be verified in field applications. The measurement of air flow is dependent on numerous parameters that are addressed in this section.

TRAVERSING METHODS

It is typical for an air balancer to check results of a capture hood by taking a velocity traverse ahead of the unit. This is a good practice, but discrepancies should be expected. Under controlled laboratory conditions, differences of 5% to 7% are not unusual. There are a number of sources of error that can account for these differences.

First, traverses are usually done with probes that are made to measure in one direction only. Air flow, especially in field conditions, is tri-dimensional and errors can result from this difference. In general, a difference of 10 degrees in probe alignment or flow direction can result in a difference of 5% of the true reading. If elbows or bends are close to the area of measurement, a non-uniform velocity profile can occur. For some field conditions, reverse air flow may occur as shown in Figure 17. This condition may be very difficult to discover since probes like thermal anemometers will measure flow in either direction.

Second, a capture hood is calibrated directly in units of volume flow over time. A traverse results in only the average velocity. To obtain volume flow, the average velocity must be multiplied by the area of the duct. Since the area is dependent on the square of the diameter for a round duct, errors in measuring the diameter will result in even larger errors in computing the volume flow. A 2% error in the area measurement will result in a 4% error in volume flow.

Third, some probes such as thermal anemometers may not be compensated for differences in atmospheric pressure or temperature. Make sure that the operating characteristics of the traversing probe are well understood when comparing results to capture hoods. Balometers are generally calibrated to read in standard volume flow. This is flow referenced to a density of .075 pounds per cubic foot (1.2 kg/m^3). The Electronic Balometer can also be set to read in actual flow, assuming atmospheric pressure is at factory or calibration conditions.

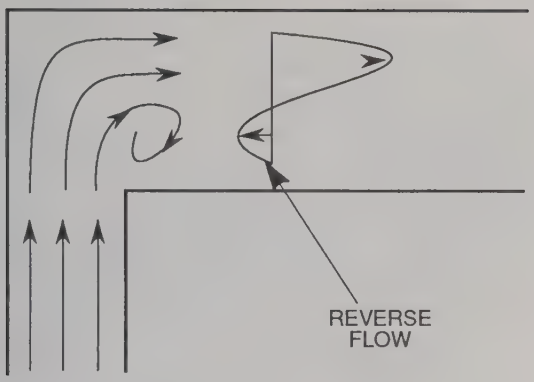


Figure 17. Reverse Flow Condition

AVERAGING CAPABILITY

All capture hoods are designed with averaging manifolds. The manifold designed for the APM 150 Electronic Balometer represents an improvement in averaging capability over previous designs. While the industry standard for this type of instrument uses 16 measuring locations, how these holes are arranged can affect the accuracy of the instrument when exposed to various flow patterns. The APM 150 Electronic Balometer is designed to bring each of the 16 sample points to a central hub where the pressure is averaged. Averaging manifolds that utilize measuring locations which are arranged in series may not, depending on flow pattern, average as well as the APM 150 Electronic Balometer manifold. A series type arrangement will have at least 2 measuring locations that are in line with each other before entering an averaging chamber. A parallel type arrangement will have each measuring location brought individually to the central averaging chamber. The APM 150 Electronic Balometer manifold has 16 measurement locations all of which are arranged in a parallel type arrangement. Differences between these manifold styles are shown in Figures 18 through 20. In applications where proportional balancing methods are being used, these differences usually will not present any problems. In applications where absolute readings are made and then compared to different model Balometers or competitive instruments, differences should be expected. The best manifold arrangement (see Figure 20) is one that has all holes in parallel with a central hub as is the case for the Electronic Balometer.

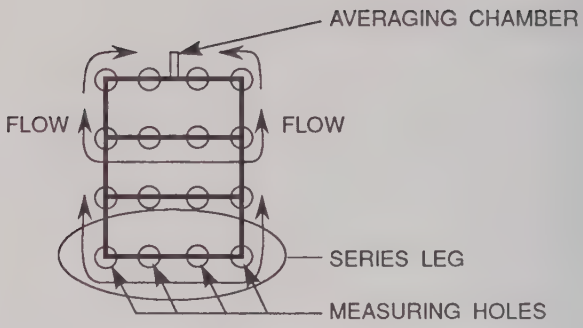


Figure 18. Series Style Manifold

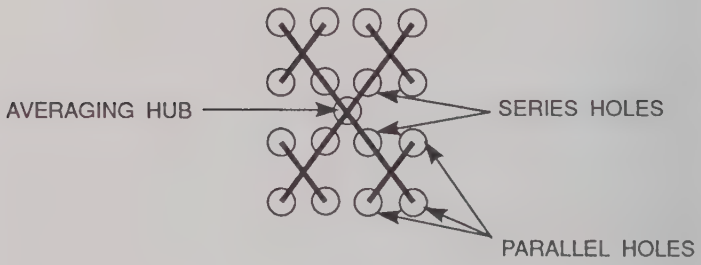


Figure 19. Parallel–Series Manifold

STANDARDS

All Balometers or hoods are calibrated to some standard. Different manufacturers or calibration facilities may use standards or methods that are different from those used at Alnor Instrument Company. Alnor uses laminar flow elements as the standard to calibrate Balometers. These are devices that are made up of a very fine honeycomb mesh. The pressure drop across a laminar flow element is approximately linear with the flow going through the element. Alnor Balometers are calibrated using a standard two foot by two square diffuser. Other manufacturers may use orifice plates or nozzles and may or may not use a diffuser.

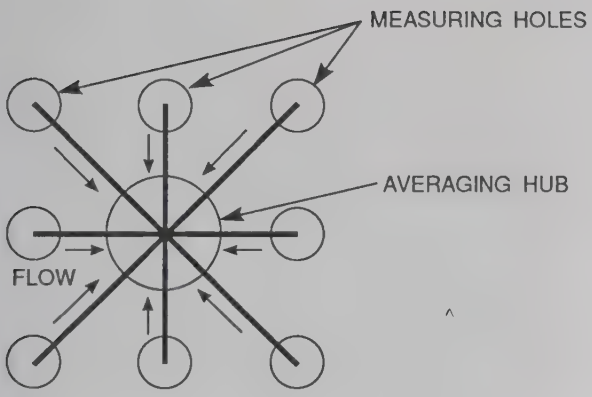


Figure 20. Parallel Manifold

When using proportional balancing techniques, these differences will not be important. However, when comparing Balometers against other hoods, or when comparing Balometers calibrated at Alnor with other calibration facilities, these differences may be important. It is not unusual to see air flow calibration differences on the order of 5% because of different standards.

BACK PRESSURE

All capture hoods induce some back pressure on the air handling system. This is because the Balometer restricts the flow coming out of the diffuser. This added resistance will alter the true amount of air coming out of the diffuser. In the majority of cases, this error is less than the accuracy of the instrument. When doing proportional balancing, this error need not be taken into account since all similar diffusers will see about the same back pressure. To determine if back pressure is significant for a system, a velocity traverse can be made ahead of the diffuser with and without the Balometer in place. The difference in the average velocity of the traverse will indicate the degree of back pressure compensation that is required on similar diffusers in the system. For example, if the average velocity is 800 FPM with the Balometer in place, and 820 FPM without the Balometer in place, the Balometer reading can be multiplied by 1.025 on similar diffusers in the system (820/800 = 1.025). As an alternative, the designer of the air handling system can predict the amount of air flow that is reduced because

of the additional pressure of the Balometer by using the curve in Figure 21. This curve indicates the pressure drop through the Balometer for different flow rates.

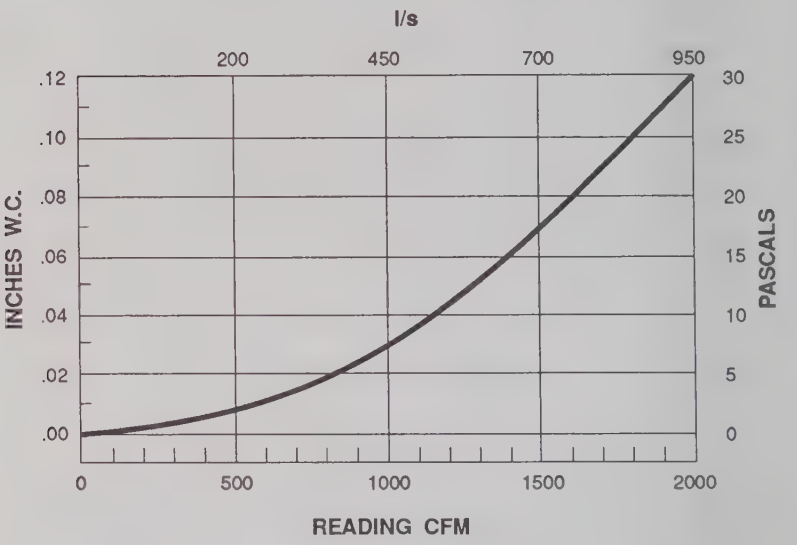


Figure 21. Backpressure Curve

TEMPERATURE

The temperature readout on the Electronic Balometer indicates general trends in the air temperature coming from a grill. The Electronic Balometer has a temperature sensor located inside an aluminum housing in back of the meter. Because of the mass of the housing, the Electronic Balometer will show a lag in temperature reading from actual if the air temperature is changing. The time response of the temperature channel depends on the amount of flow passing through the Balometer. For flows under 200 CFM (100 l/s), the temperature time response is on the order of minutes. For fast measurements of air flow temperature, the APM 150 probes are recommended. To compare the temperature reading of the Electronic Balometer to a standard, the air flow temperature must remain constant to within 0.25 degrees C.

ATMOSPHERIC PRESSURE

Above 500 CFM (250 l/s), large changes in atmospheric pressure can affect readings from the Balometer when the unit is displaying values in actual "ACtU" mode. The correct value is inversely proportional to the atmospheric pressure. A change in atmospheric pressure of –3% will require the display to be increased by +3%. No corrections are required when the unit is measuring in standard "STnd" mode. See the section CORRECTION FACTORS for additional information.

NOTE

When using the Balometer, make sure that a complete seal is made around the diffuser. Any leaks will cause measurable errors.

7 MAINTENANCE

NYLON HOODS

The hoods may be hand washed periodically using cool water and a mild detergent. When washing, do not let the material come in contact with sharp corners or other objects which may tear the hood.

MANIFOLD

The manifold should be checked before using to be certain that the sensing holes have not become clogged with dirt or dust particles. Inspect for leaks which may be caused by a poor connection to the sensor housing through the long pieces of flexible tubing. Also check to make sure that the O-rings used to seal the tubes to the center hub are in place. The manifold may be cleaned using mild detergent and warm water. Do not immerse the manifold in water. It is recommended that cleaning be done with the manifold in place, and with care.

BATTERY REPLACEMENT AND EXAMINATION

Examine the batteries at least every two months for signs of corrosion. For details on opening the battery cover, refer to the PREPARATION FOR USE section. Remove the batteries if there are any signs of corrosion or moisture. Clean the affected parts with a clean cloth moistened with water only. Allow the parts to dry thoroughly and install fresh batteries. If the instrument is not to be used for more than two months, remove the batteries and store them in a separate plastic container.

Replace the batteries whenever LO BAT appears on the display. However, accurate readings will be maintained until the display is blank.

Rechargeable batteries are not recommended because of short life. Use three size AA alkaline batteries.

METER

The meter case may be cleaned with a mild dish washing detergent and water solution on a damp cloth to remove finger marks, oils or residue. When cleaning the window area of the meter, use light pressure to prevent the window from becoming distorted. Do not use abrasives or solvents. Do not immerse the meter or allow liquids to enter the case. Dry the instrument thoroughly after cleaning.

RECALIBRATION

Your Balometer may be returned to the factory or authorized distributor in your country for calibration. If proper facilities are available, the procedures outlined in the CALIBRATION section of the manual may be used. When shipping the Balometer for factory recalibration, pack it carefully and follow the instruction for return outlined in this manual.

The calibration of the instrument and meter should be performed every six months.

NOTE

There are no user serviceable parts or batteries inside the sensor housing. Do not remove the sensor housing cover.

8 TROUBLE SHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES and CORRECTIVE ACTIONS
No Display	Instrument is not on — Press ON
	Dead batteries - replace batteries
	Batteries incorrectly installed — check polarity and correct if required
LO BAT indication flashing	Battery voltage is low — replace batteries
Random pattern on display	Battery voltage is too low — replace batteries
Display does not change or flashes	HOLD/CALC button was depressed — press hold again to release.
	Very stable input — unlikely. Instrument requires reset. Press OFF then ON again.
Display shows 0	Input condition below minimum allowed — see SPECIFICATION section of manual for limits.
Display shows Or	Input condition above maximum allowed — see SPECIFICATION section of manual for limits.
Display shows OPEn	Probe or sensor not connected or loose — check connection to meter. Tighten connector if required.
	Probe or sensor damaged — call factory or your Alnor representative.
Units not as expected after turn on	Meter was turned off before values appeared after CHANGE button was used — wait until values are displayed before pressing OFF. Reset to desired units.
HOLD/CALC Button on handle does not work	Connector between handle and meter is not plugged in — Connect hold cable to sensor module.

SYMPTOM	POSSIBLE CAUSES and CORRECTIVE ACTIONS
Measurement is erratic	Input is unstable — interpret value from high and low display limits or increase time constant setting.
Erroneous readings	Wrong measurement Units — verify correct units.
	Atmospheric pressure is significantly different from factory calibration when running in actual mode — perform manual correction.
	Hood frame not sealing properly around diffuser or grill — Press hood evenly against diffuser.
	Hood torn - Replace or repair hood.
	Exhaust mode was incorrectly chosen when measuring supply flow or vice versa — Check mode. Display shows "–" sign for exhaust mode. Absence of "–" indicates supply mode. Use arrow keys to select desired mode. Note: Meter always starts up in supply mode.
	Connection between manifold and sensor/meter is broken — Repair.
	Meter is out of calibration — Check calibration and adjust if required.
	Sensor module is out of calibration — Check calibration and adjust if required.
	Manifold is damaged — Repair or replace manifold.
	Manifold holes are plugged — See Maintenance section of manual.
	Condensation inside sensor module — allow unit to warm up to room temperature.

9 THEORY OF OPERATION

GENERAL

The Electronic Balometer collects air using a capture hood and averaging manifold. Although the Electronic Balometer may capture as much as 2000 CFM (945 l/s) of air, only a very small portion of this air is gathered by the averaging manifold and sent to the sensor. The averaging manifold consists of two sets (supply and exhaust) of 16 legs. Each leg has only one measuring hole. The holes are arranged in a radial pattern. Air can enter the manifold from either set of legs. As shown in Figure 22, the sensor is connected to an electronic module. The sensor module is connected to the meter and display through a 12 pin connector. Since flow can be measured by the Electronic Balometer in either direction, the user must make the proper selection (Supply or Exhaust) to get a correct reading.

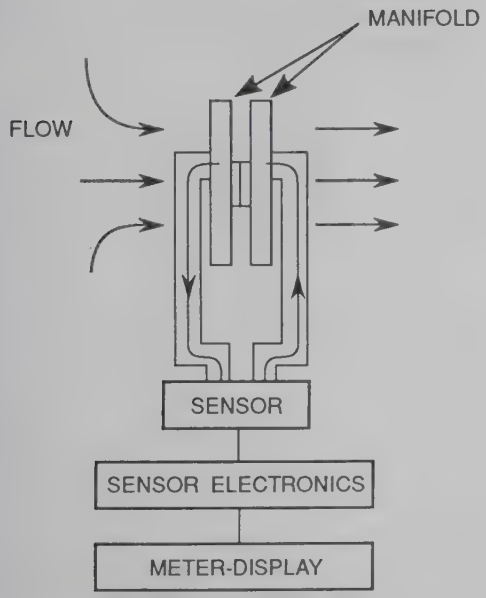


Figure 22. APM 150 Electronic Balometer System Block Diagram

SENSOR BLOCK DIAGRAM

Two sensors are used to measure the air flow rate. See Figure 23. One sensor is a glass coated heated thermistor. The other sensor is a nickel wire element. The heated thermistor is kept at a constant temperature and is used to measure the flow through the sensor housing. The nickel sensor is used to compensate for changes in the ambient air temperature. Changes in atmospheric pressure will affect the displayed output when measuring in actual mode. The APM 150 Electronic Balometer does not sense atmospheric pressure changes sensed automatically. These changes must be made manually as described in the section CORRECTION FACTORS. Each sensor has support circuitry consisting of amplifiers and electronic references. There are no potentiometers on the sensor electronic board. All calibration is performed electronically. The sensor electronic board has its own memory so that any APM 150 meter can be used to display the measurements. Probe identification, factory and user calibration constants, last set of units used, and other information are stored in the probe's memory. Power is supplied to this circuit by the batteries located in the meter. This power is regulated by circuitry located on the sensor board. There are no batteries on the sensor board.

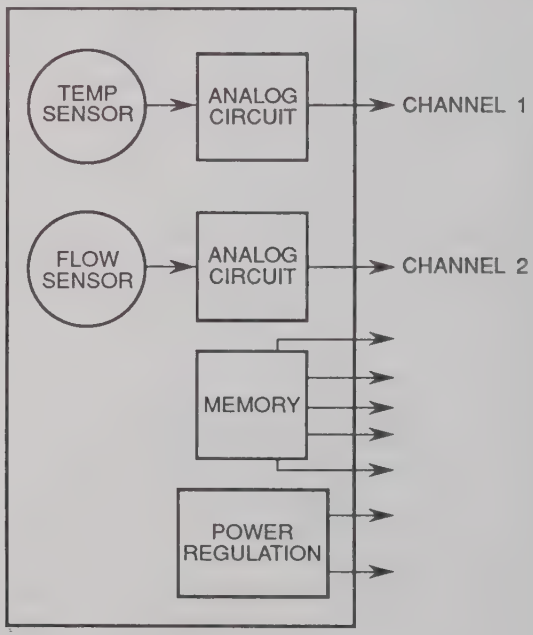


Figure 23. Sensor Block Diagram

METER BLOCK DIAGRAM

The APM 150 meter is designed to read a variety of probes. An adapter cable is required in most situations. Because probe calibration is stored within the probe or sensor housing and not with the meter, meters are fully interchangeable. A block diagram of the meter is shown in Figure 24.

Probes used with the APM 150 meter in general are designed with one or two sensors. Each sensor has its own output channel designated as channel 1 or channel 2 along with appropriate common lines. These channels are the input to the meter. A data bus is also used so that the meter can read the probe's memory. The probe's memory contains the probe identification, calibration information, time constant setting and units information.

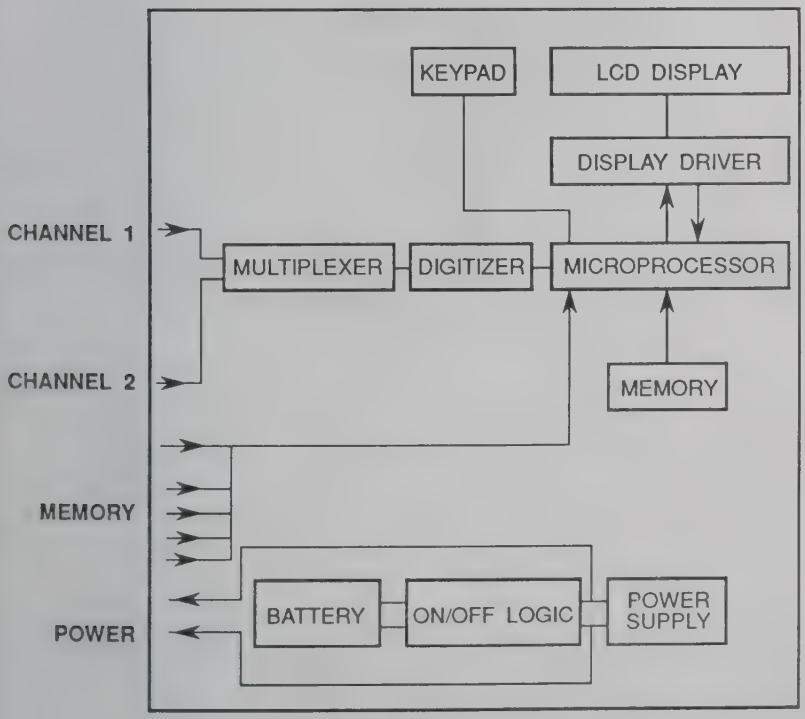


Figure 24. Meter Block Diagram

Under the control of the microprocessor, a multiplexer connects one of several inputs to the digitizer. The digitizer converts the signal to numeric data which is usable by the microprocessor in numeric calculations. The microprocessor analyzes the sensor output and related signals converting them to data that is displayed on the liquid crystal display (LCD). Instructions for operation used by the microprocessor are stored in permanent memory. Meter calibration constants and measurement units are also stored in memory. The display driver converts the signals from the microprocessor to signals required by the LCD. The function selector consists of the ON, OFF, CHANGE, HOLD/CALC, SUPPLY and EXHAUST switches on the front of the meter. It also consists of the concealed meter Set Up switch located near the batteries. The switches transmit user instructions to the microprocessor.

STANDARD AND ACTUAL MEASUREMENT

The Electronic Balometer displays volumetric flow rate in two different ways. In the mode designated by "ActU" on the display, the unit performs no corrections on the displayed value. Under "Normal" atmospheric conditions the unit will read accurately. At locations where the atmospheric pressure is significantly different from that at which it was calibrated, a correction factor needs to be applied (See section on correction factors). In the mode designated by "Stnd" on the display, the Electronic Balometer performs a correction using the measured temperature. The displayed value is corrected to Standard conditions of 70°F (21°C), that is, what the volume of air passing through the hood would be if it were at 70°F (21°C). This mode is useful for comparison to mechanical (vane deflection) balancing instruments. The equation (based on the ideal gas law) employed is:

"Stnd" = "ActU" * $T_{standard}$ / $T_{measured}$

Where:

$T_{measured}$ is the measured absolute temperature

$T_{standard}$ is 70°F + 460 (21°C + 273)

Due to the nature of the sensor module no pressure corrections are needed when in "Stnd" mode. It should be noted that the pressure correction equation is also based on the ideal gas law.

10 CALIBRATION

GENERAL — METER CALIBRATION

The APM 150 meter incorporates a detailed program that can be used to calibrate the meter or attached sensor. The procedure should only be attempted by persons having the proper equipment. Note that any attempt at recalibration voids all calibration certification that may have accompanied the instrument.

EQUIPMENT REQUIRED

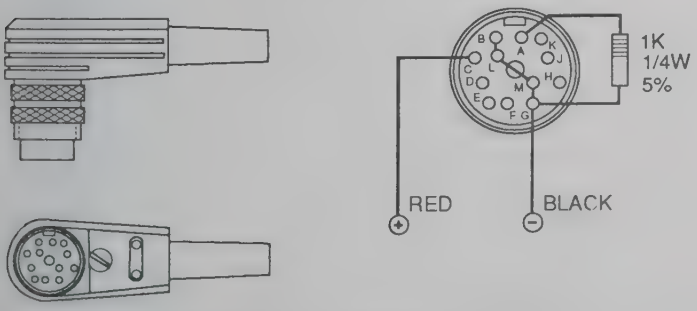
To calibrate the meter, the following equipment is required:

1. Reference voltage source 0 to 2.0 volts, minimum ±0.5 mv accuracy.
2. 12 pin connector cable (see Figure 25) to connect meter to calibration source. A special cable assembly is available from Alnor. See List of Models and Parts.

To calibrate the probe or base of the Electronic Balometer, the following additional equipment is also required:

1. Wind tunnel with flow standard
2. Temperature standard
3. Notepad and calculator

CALIBRATION CONNECTION	
1	CONNECT G M L B
2	CONNECT 1K 1/4W RESISTOR A TO G
3	CONNECT '-' INPUT TO G
4	CONNECT '+' INPUT TO C



RIGHT ANGLE SCREWLOCK CONNECTOR
12 PINS – SILVER CONTACTS
AMPHENOL #703-91T-3635-005

Figure 25. Calibration Connector Assembly

METER PREPARATION

1. Make sure that the reference voltage source is at its operational temperature. Usually it should be turned on for at least one hour before use. Refer to the owner's manual for the particular equipment in use.

2. If the LO BAT indicator is flashing when the APM 150 meter is turned on, replace the batteries before proceeding.

3. Remove the battery compartment door by loosening the battery cover hold down screw, lifting the screw up and then pushing the cover to the left. Lift up on the screw to pull the cover out. This action give access to the Set Up switch.

4. Connect the 12-pin connector to the meter. Connect the opposite end to the reference voltage source.

5. Set the voltage source to +2.000 volts.

METER CHECK

1. While holding down the Set Up switch, turn the meter on. Release the Set Up Switch. Let the APM 150 meter warm up for 15 minutes.

2. The meter will display "Unit". Press and release the Set Up switch until "CAL" is displayed. At this point, press and release the CHANGE switch. This places the meter in the calibration mode. While in this mode, the following menu items are available:

SC 2	Show constants for channel 2 (supply flow).
SCr2	Show constants for channel 2 (reverse or exhaust flow)
SC 1	Show constants for channel 1 (temperature).
CC 2	Change constants for channel 2 (supply flow).
CCr2	Change constants for channel 2 (reverse or exhaust flow)
CC 1	Change constants for channel 1 (temperature).
360	Calibrate meter for voltage input on channel 1.
UOLT	Display voltage reading from channel 1.
ArEA	Area factor of base.

3. Determine if the APM 150 meter requires calibration by viewing the indicated voltage supplied by the calibration source. To view the voltage, press and release the Set Up switch until "UOLT" is displayed.

4. After the meter displays "UOLT", briefly press and release the CHANGE switch. The meter will display "SCAn" followed by a measured voltage value. Record the reading and compare it to the input value. If the APM 150 meter is within the tolerance indicated in the SPECIFICATIONS section, the meter does not need to be calibrated. If this is the case, turn the instrument off and disconnect the APM 150 meter from the voltage source. Replace the battery compartment cover by inserting the "wings" on the left into the case and pushing to the left while pressing in. If the meter is beyond the allowed specification, turn the meter OFF and proceed to the METER CALIBRATION section.

METER CALIBRATION

1. While holding down the Set Up switch, turn the meter on. Release the Set Up switch.

2. The meter will display "Unit". Press and release the Set Up Switch until "CAL" is displayed. At this point, press and release the CHANGE switch. This places the meter in the calibration mode.

While in this mode, the following menu items are available:

SC 2	Show constants for channel 2 (supply flow).
SCr2	Show constants for channel 2 (reverse or exhaust flow)
SC 1	Show constants for channel 1 (temperature).
CC 2	Change constants for channel 2 (supply flow).
CCr2	Change constants for channel 2 (reverse or exhaust flow)
CC 1	Change constants for channel 1 (temperature).
360	Calibrate meter for voltage input on channel 1.
UOLT	Display voltage reading from channel 1.
ArEA	Area factor of base.

3. To calibrate the APM 150 meter, press and release the Set Up switch until the meter displays "360", then press and release the CHANGE switch.

4. The APM 150 meter will display "2000". At this point, set the reference voltage source to +2.000 volts ±0.5 mv. Wait 5 seconds. Press and release the CHANGE switch.

5. The APM 150 meter will display "0". At this point, set the reference voltage source to +0.000 volts ±0.5 mv. Wait 5 seconds. Press and release the CHANGE switch.

6. The APM 150 meter will display "700". At this point, set the reference voltage source to +.700 volts ±0.5 mv. Wait 5 seconds. Press and release the CHANGE switch.

7. The display will show "360". Press and release the Set Up switch to advance to "UOLT". Press and release the CHANGE switch. The meter will show "SCAn" followed by voltage measurements. Check voltages as required. Verify that the meter voltages are now within specification. If not, repeat the procedure.

8. Turn the APM 150 meter off and disconnect the voltage source. Replace the battery cover.

GENERAL — PROBE CALIBRATION

The linearization method used to recalibrate the sensor or probe of the Electronic Balometer involves choosing the constants that will produce the best calibration. The forms of the calibration equations are:

For flow less than 200 CFM (94 l/s):

Displayed value supply mode = C1 * (Factory calibration value)
Displayed value exhaust mode = Cr1 * (Factory calibration value)

For flow greater than 200 CFM (94 l/s):

Displayed value supply mode = C2 * (Factory calibration value) + C3
Displayed value exhaust mode = Cr2 * (Factory calibration value) + Cr3

For temperature:

Displayed value = C4 * (Factory calibration) + C5

These constants are shown graphically in Figures 26 and 27. The values of C1, Cr1, C2, Cr2, C4 and C5 can be adjusted by the user. The values of C3 and C3r are automatically computed based on the values chosen for C1, C1r, C2 and C2r. Typically the values for C1, C1r, C2 and C2r in the above equations are set to 1.00 when shipped from the factory. The values of C3, Cr3 and C5 are typically set to 0.0. The user has the ability to change C1, Cr1, C2 and Cr2 in the above flow equations to values between .8 and 1.2. This means that the displayed flow can be adjusted (±) 20% from the normal factory calibration. The value of C4 in the temperature equation can be changed from .9 to 1.1. The value of C5 can be changed from −5 to +5 in increments of .1 C. This means that the displayed temperature can be adjusted (±) 10% from the factory calibration.

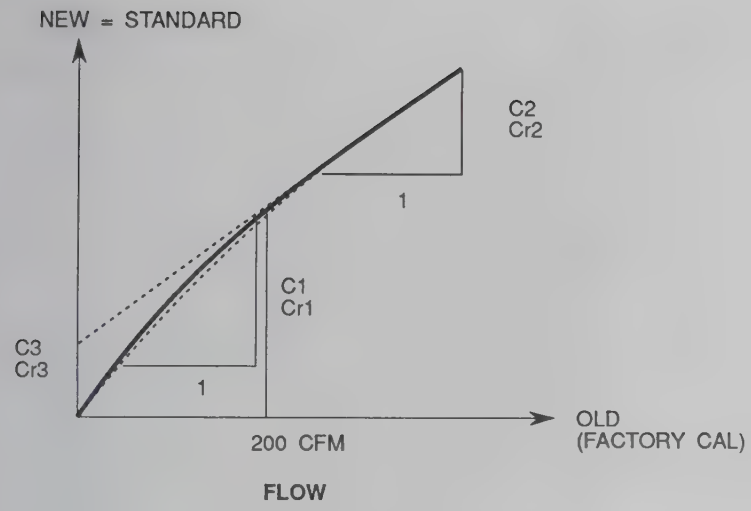


Figure 26. Flow Constants

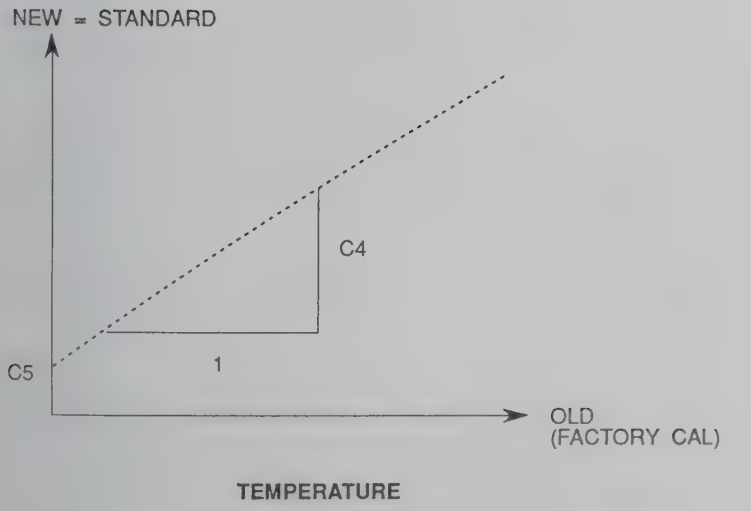


Figure 27. Temperature Constants

The basic calibration steps for the probe calibration are outlined below:

A. View the calibration constants that are stored in the probe and record the values in case the original calibration needs to be retrieved.

B. Set the calibration constants C1, Cr1, C2, Cr2 and C4 to 1 if required. Set the calibration constant C5 to 0. (C3 and Cr3 will automatically be set to 0).

C. Mount the Electronic Balometer on the volumetric flow rate standard against which it is being calibrated. Record the standard's readings along with the displayed readings of the Electronic Balometer.

D. Use appropriate statistical techniques to compute the constants C1, Cr1, C2, Cr2, C4 and C5. Possible methods that may be used are:

   1. Least square curve fit procedure
   2. Simple averaging of errors

Detailed calibration steps follow below.

PROBE TEMPERATURE CALIBRATION

NOTE

Temperature calibration will affect flow calibration. If temperature calibration is required, it must be done prior to flow calibration. Flow must always be checked and most likely calibrated after temperature calibration.

It is recommended that the temperature be checked in a moving stream of air of at least 1100 CFM (519 l/s). The temperature standard should be placed right next to the aluminum housing of the thermal sensor which is located inside the base in back of the meter.

1. While holding down the Set Up switch, turn the meter on. Release Set Up switch.

2. The meter will display "Unit". Press and release the Set Up switch until "CAL" is displayed. At this point, press and release the CHANGE switch. This places the meter in the calibration section mode.

3. Record the calibration constants for temperature. To view the constants, press and release the Set Up switch and step through the following menu items.

SC 2	Show constants for channel 2 (supply flow).
SCr2	Show constants for channel 2 (reverse or exhaust flow)
SC 1	Show constants for channel 1 (temperature).

When the meter displays "SC 1" press and release the CHANGE switch.

4. The display will show the values of C4 and C5. You may press CHANGE again to review these numbers. Record these values. If the values are 1.00 and 0.0, turn the meter off and proceed to step 7. Otherwise, continue on to step 5 to change these values to 1.00 and 0.0.

5. Press and release the Set Up switch. The display will show "CC 2". Press and release the Set Up Switch again and the display will show "CCr2". Press it one more time and the display will show "CC 1".

6. Press and release the CHANGE switch. The display will show .90. Press and release the Set Up switch until the display shows 1.00. Press and release the CHANGE switch. Now C4 equals 1.00. The display will show -5.00. Press and release the Set Up switch until the display shows .00. Press and release the CHANGE switch. This sets C5 to .00. The display will show "CC 1". Turn the meter off.

7. Turn the meter on and set it to measure temperature. Record the temperatures as read by the standard and the APM 150 meter. Divide the standard readings by the APM 150 reading. A sample set of typical data is shown below:

Standard (C)	APM 150 (C)	Standard/APM 150
25.3	25.8	.98
30.2	30.9	.98

For the above data, the constant C4 would be chosen as .98. Because the ratio is .98 for two different temperatures, it is assumed in this example that the ratio is constant for all other operating temperature. For this reason, the offset constant C5 would be chosen as 0.0. More sophisticated statistical techniques such as least square curve fitting may be used to reduce the overall error of the calibration process.

NOTE

To change the temperature of the air stream, a heater may be used upstream of the manifold.

8. After C4 and C5 are determined, they must be programmed into the meter. To do this, turn the meter on while holding down the Set Up switch. The display will show "Unit". Press and release the Set Up switch until "CAL" appears. Depress the CHANGE switch. The display will show "Sc 2". Press and release the Set Up switch until "CC 1" appears.

9. Repeat the procedure described in step 6 above, but enter the new values for C4 and C5.

10. Turn the meter off. The result should be checked to verify that the Electronic Balometer has been correctly calibrated.

PROBE SUPPLY FLOW CALIBRATION

NOTE

Temperature calibration will affect flow calibration. If temperature calibration is required, it must be done prior to flow calibration. Flow must always be checked and most likely calibrated after temperature calibration.

1. While holding down the Set Up switch, turn the meter on. Release the Set Up switch.

2. The meter will display "Unit". Press and release the Set Up switch until "CAL" is displayed. At this point, press and release the CHANGE switch. This places the meter in the calibration mode. The meter will display "SC 2" (supply mode).

3. Record the calibration constants for supply flow. To view the constants, press and release the CHANGE switch.

4. The display will show the values of C1, C2 and C3 followed by "SC 2". You may press CHANGE again to review these numbers. Record these values. If the values are 1.00, 1.00 and 0.0, turn the meter off and proceed to step 7. Otherwise, continue to step 5 to change these values to 1.00, 1.00 and 0.0.

5. Press and release the Set Up switch. The display will show "SCr2". Press and release Set Up switch again and the display will show "SC 1". Press it one more time and the display will show "CC 2" (supply mode).

6. Press and release the CHANGE switch. The display will show .80. Press and release the Set Up switch until the display shows 1.00. Now, C1 equals 1.00. Press and release the CHANGE switch. The display will again show .80. Press and release the Set Up switch until the display shows 1.00. Now, sets C2 equals 1.00. The value of C3 will automatically be set to 0.0. The display will show "CC 2". Turn the meter off.

7. Turn the meter on and set it to measure "supply" flow. Place the Electronic Balometer on the flow tunnel so that air is entering the Balometer at the hood and leaving at the base. Make sure the Balometer is set to supply mode. Record the flow as read by the standard and the APM 150 meter. Divide the standard readings by the APM 150 reading. A sample set of typical data is shown below:

Standard (CFM)	APM 150 (CFM)	Standard/APM 150
100	95	1.05
500	520	.94
1000	1050	.95

For the above data, the constant C1 (used for flows below 200 CFM) would be chosen as 1.05. The constant C2 (used for flows above 200 CFM) would be chosen as either .94 or .95. More sophisticated statistical techniques such as least square curve fitting may be used to reduce the overall error of the calibration process.

8. After C1 and C2 are determined, they must be programmed into the meter. To do this, turn the meter on while holding down the Set Up switch. The display will show "Unit". Press and release the Set Up switch until "CAL" appears. Press the CHANGE switch. The display will show "SC 2". Press and release the Set Up switch until "CC 2" appears.

9. Repeat the procedure described in step 6 above, but enter the new values for C1 and C2.

10. Turn the meter off. The result should be checked to verify that the Electronic Balometer has been correctly calibrated.

PROBE EXHAUST (RETURN) FLOW CALIBRATION

To calibrate the return or exhaust mode, repeat steps 1 through 10 in the PROBE SUPPLY FLOW CALIBRATION section, but change Cr1 and Cr2 instead of C1 and C2. Return mode constants are observed under menu heading "SCr2" instead of "SC 2". Also, make sure the Electronic Balometer is placed in the flow tunnel so that air flows into the unit at the base, and out at the hood. Verify that the meter is in exhaust mode by observing the "–" on the display.

11 CORRECTION FACTORS

Balometers are calibrated under local conditions of temperature and atmospheric pressure. Temperatures range between 68 and 77°F (20 and 25°C). Atmospheric pressures range from 28.7 and 30.2″ Hg (729 and 767 mmHg). If standard flow is being measured on the Electronic Balometer, no correction factors are required. If actual flow is being measured, corrections are required for atmospheric pressure changes. If it is desired to take this effect into account, use the following equation:

Actual flow = Displayed Flow (ACtU mode) * $P_{calibration}$ / P_{actual}

where:

$P_{calibration}$ = atmospheric pressure at time of calibration

P_{actual} = actual atmospheric pressure

12 SPECIFICATIONS

Range	Volume flow: 50 to 2000 CFM 85 to 3400 m^3/h 23 to 945 l/s Temperature: 32 to 122°F 0 to 50°C APM 150 Meter: 0 to 3 volts
ACCURACY*	At temperatures between 50 and 104°F(10 to 40°C) Volume flow: Supply Mode ±3% of indicated reading ±7 CFM ±3% of indicated reading ±3.3 l/s ±3% of indicated reading ±12 m^3/h Exhaust Mode ±4% of indicated reading ±7 CFM ±4% of indicated reading ±3.3 l/s ±4% of indicated reading ±12 m^3/h Temperature, steady input: ±0.5% of indicated reading ±1°F ±0.5% of indicated reading ±0.5°C Meter: ±0.2% of reading or ±2mv, whichever is greater
Resolution	Volume flow: 1 CFM 1 l/s 1 m^3/h Temperature: 0.1°C (0.1°F)
Response Time	Volume Flow: User adjustable from 2 to 10.5 seconds

* Any attempt at recalibration by the user voids all calibration certification provided with the instrument.

Units Displayed	CFn Cubic Feet per Minute cnh Cubic Meter per Hour LPS Liters per Second C Degrees Centigrade F Degrees Fahrenheit
Battery	three 1.5-V AA alkaline
Battery Life	8 hours minimum continuous use at 300 CFM
Display	4 1/2 digit 3/8″ (9.5 mm) high LCD (Liquid Crystal Display) with LO BAT indicator
Operating Temperature	10 to 40°C (50 to 104°F)
Storage Temperature	–40 to 65°C (–40 to 150°F)
Operating Weight	Instrument with 2 X 2 (610 X 610 mm) hood: 8 lbs 12 oz (4 Kg) Meter: 10 oz (280 gm)
Shipping Weight	21 lbs 6 oz (9.7 kg)
Dimensions	Instrument Assembly: APM 150 Meter: 7.2″ X 3.2″ X 1.3″ (182 mm X 81 mm X 33 mm) Electronic Balometer Base: 20″ (50.8 cm) diameter X 7.1″ (180 mm) height Carrying Case: Approximately 26″ X 26″ X 8″ (66 X 66 X 20 cm)
Connector	Sensor: Round locking 12 pin Hold: Miniature Phono Jack
Field Calibration	Flow: ±20% change from factory flow calibration
Adjustment Range	Temperature: ±10% change from factory flow calibration
Statistics	9999-point running average of volume and temperature, plus 9999-point TOTAL VOLUME. The maximum TOTAL VOLUME that can be displayed is19999. Statistic are set to zero at power-up.
Operating Temperature of Heated Thermistor	Approximately 90°C (194°F)

Specifications subject to change without notice.

NOTES

WARRANTY/REPAIR INFORMATION

Contact the distributor in your country, or Alnor Instrument Company directly, before returning your instrument. In North America, contact Alnor before returning your instrument to the factory. See INSTRUCTIONS FOR RETURN. Follow the procedure carefully as it will expedite processing. Failure to follow the procedure will/may cause return of the unit unrepaired. Send your instrument to the factory transportation prepaid. To assure fast turn-around time, fill out this form with as much detail as possible and attach it to the instrument.

Instrument Model _____

Serial Number _____

Date of Purchase _____ Where Purchased _____

Describe Malfunction _____

_____

_____

Describe Environment _____

_____

_____

Return Instrument to:

Name _____

(Your name or company)

Address _____

_____

Telephone _____

Address Correspondence to:

Name _____

Address _____

Telephone _____

INSTRUCTIONS FOR RETURN

Damaged in Transit

All shipments are carefully examined by Alnor Quality Assurance and carefully packed for shipment. On receipt, if the shipping container appears to have been damaged during shipment, the instrument should be thoroughly inspected. The delivering carrier's papers should be signed noting the apparent damage.

If the instrument itself has been damaged, a claim should be promptly filed against the carrier by the customer. The selling agent will assist the customer by supplying all pertinent shipping information; however, the claim must be filed by the insured.

If the instrument is damaged beyond use, a new order should be placed with Alnor while awaiting reimbursement from the carrier for the damaged instrument.

Call Alnor directly for assistance if necessary.

Malfunction

Please follow these steps should you require factory service or repair of your Alnor Instrument:

1. Write or telephone the Alnor distributor in your country for cost of repair or recalibration and shipping instructions. Obtain a Purchase Order or purchase order number from your Purchasing Department showing instrument model number and cost of repair and/or recalibration. Securely package your instrument in a strong container surrounded by at least two inches (5 cm) of suitable shock-absorbing material. Include the Purchase Order, or Reference the Purchase Order on your packing slip.
2. In North America, telephone the Repair Department at the USA factory for cost of repair or recalibration, Authorization for Repair (AFR) number, and shipping instructions. On instruments being returned to the factory for recalibration, determine whether you prefer:

— Certificate of Calibration, no data (states instrument checked and found to be within accuracy claimed and specifications listed in current literature).

— Certificate of Traceability to National Institute of Standards and Technology (NIST, formerly NBS) with data (states instrument compared with factory standard traceable to NIST, lists of calibration data, i.e., "Standards reads..." and "This instrument reads...")

Obtain a Purchase Order or purchase order number from your Purchasing Department showing instrument model number and cost of repair and/or recalibration. Securely package your instrument in a strong container surrounded by at least two inches (5 cm) of suitable shock-absorbing material. Include the Purchase Order, or Reference the Purchase Order on your packing slip. Mark the outside of the shipping container with the AFR Control number.

3. Forward the instrument prepaid. See back cover for factory addresses.

Please note that instruments received improperly marked or without an accompanying Purchase Order may be returned at your expense. Please also note that if an AFR# has been assigned, it will be cancelled if the instrument is not received by ALNOR within 60 days.

WARRANTY

Alnor Instrument Company (Alnor) warrants this product to be free of defects in material and workmanship for a period of two years from the date of original purchase. If the product should become defective during the warranty period, Alnor will repair it or elect to replace it free of charge under the following conditions:

1. Product is returned postpaid per the instructions for return, located in the owner's manual.

2. Owner submits proof of original date of purchase.

3. Alnor will inspect product for defects in material and workmanship. Alnor's decision as to existence of defect, and in the case of defect, to repair or replace will be final.

THIS WARRANTY IS EXCLUSIVE. THERE ARE NO OTHER WARRANTIES EITHER EXPRESS OR IMPLIED. SPECIFICALLY AND WITHOUT LIMITATION, THERE IS NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE.

This warranty is void if product is misused, used contrary to procedures set forth in the owner's manual, or if product is serviced by anyone other than Alnor's authorized service. This warranty does not cover consumables such as light bulbs, paper, batteries, etc.

Alnor's liability for this product is limited to the above stated warranty and shall not in any event exceed the cost of the product. In no event will Alnor be liable for any direct or consequential damages, including but not limited to lost profits, loss of use, inaccuracies, loss of data, dismantling or reinstallation.

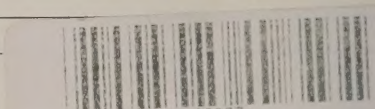
Equipment Log

DATE OF
PURCHASE _____

CALIBRATION RECORD

1. _____	2. _____	3. _____
4. _____	5. _____	6. _____
7. _____	8. _____	9. _____
10. _____	11. _____	12. _____

Notes: _____



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